Immersion Container Technologies

Due Diligence and Validation

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Introduction

Immersion cooling for crypto miners is an effective method to substantially increase hash rate by immersing the miners in a dielectric fluid. Currently ambient air supplied by fans at high flow rates is the primary method of cooling miners and other computational equipment e.g. GPU's. Immersion cooling not only improves hash rate but it is generally not constrained by ambient temperature so immersion cooling can be implemented in areas that would not easily support air cooling. This is important because much of the available low cost power is in areas that have high summer ambient temperatures.

A list of four suppliers of Immersion cooling systems was selected with the intent of ranking them in accordance with several criteria. There are other suppliers but these four are recommended as potential suppliers.

Ranking Criteria

The suppliers were contacted to provide information on the following criteria which is important to the ranking process:

1. Container dimensions for length, width, and height (feet).
   There must be a minimum floor area (length x width) to facilitate access for surveillance and maintenance. If the floor area is too large, the number of containers that the proposed site could support may be too restrictive.

2. Maximum power per container (kw).
   The power density (number of miners x (power/miner)) should be high in order to maximize revenue per container. The economy of scale should improve in proportion to container power.

3. Power per ft^2 of floor area (kw per ft^2).
   This criterion is also an indication of power density. For a given container floor area which is approximately length x width, it shows how power is distributed over the footprint of the container. If the total footprint of the containers on a site is the same regardless of the container size, then a higher number for this criterion also will result in a higher site MW usage.

4. Cost per container ($)
   All other criteria being equal, the lowest cost per container would govern.

5. Container cost per kw ($/kw).
   The container cost per kw is an excellent indicator that describes the value associated with the purchase. Other costs associated with operation both fixed and variable need to be considered in determining the present value over the life of the container.

6. Number of miners per container.
   The total number of miners that the container can accommodate was obtained from the supplier.

7. The cost per miner ($/miner).
   This is the ratio of the container cost to the number of miners that the container can accommodate. This criterion shows that a high container cost may be justified if it can accommodate a large number of miners.

8. Delivery time per container i.e. time from P.O to site delivery (weeks).
   When a site demands an expedited timeline for full implementation of containers then this criterion becomes critical.

9. Container production rate (number per delivery period).
   Criterion 9 along with criterion 8 is critical when the site demands an expedited timeline for full implementation of the containers.

10. Hash rate improvement vs air cooled containers (%).
    Immersion cooling allows for overclocking miners. Overclocking in air cooled containers may not be possible especially during periods of warm weather.

Supplier Presentation

1. DCX Corporation is headquartered in Poland. The company specializes in Immersion Cooling Systems and can supply both modular container units and large systems that can be installed in buildings. DCX is the supplier of the 11 MW single phase liquid immersion cooling system that is being installed in a building at the Big Springs, Tx site. The largest modular container unit that can be supplied as described on the DCX website is a 40 ft container that can accommodate 1080 miners and 3.2 MW density. DCX has been requested to provide information on the 10 criteria but cannot supply it until late in September or early October due to workload on the Big Springs project. The system at Big Springs is comprised of 246 liquid cooling containers that can each accommodate 12 miners, 6 primary cooling loops containing a mixture of ethylene glycol and demineralize water, and 6 dry coolers that are located outside of the building. The system is sound and expected to function as designed. Although information on the modular containers has not been provided, it is expected that the design will be very similar to that at Big Springs but on a smaller scale.

2. CES Intelliflex is headquartered in Edmonton, Alberta. The company produces modular container single phase liquid immersion cooling systems of various sizes ranging from 1.0 MW up to 5.0 MW. The CES design circulates the dielectric fluid through an air-cooled heat exchanger that is located outside of the container (can be roof mounted) so a separate cooling water loop is not

required. This method of cooling the dielectric fluid should improve efficiency and optimize the Power Usage Effectiveness (PUE). After having discussions with CES and reviewing some design documentation, their immersion cooling system is sound and is expected to function as designed.

3. Rykor Energy Systems is headquartered in Massachusetts and has a manufacturing facility in Livingston Texas. The company produces modular container single phase liquid immersion cooling systems with sizes up to approximately 1.0 MW. The Rykor design circulates the dielectric fluid through an air-cooled heat exchanger that is located outside of the container, so a separate cooling water loop is not required. This method of cooling the dielectric fluid should improve efficiency and optimize the Power Usage Effectiveness (PUE). Rykor is currently supplying containers to a client and may temporarily be constrained to provide large quantities of complete modules to Compute North. They can supply incomplete modules and provide personnel onsite to complete the installation. After having discussions with Rykor and reviewing some design documentation, their immersion cooling system is sound and is expected to function as designed.

4. Midas Green Technologies is headquartered in Austin Texas. The company produces modular container single phase liquid immersion cooling systems with sizes up to approximately 1.8 MW. The Midas Green design uses a separate ethylene glycol and demineralized cooling water loop that removes heat from the dielectric fluid through a heat exchanger. After having discussions with Midas Green and reviewing some design documentation, their immersion cooling system is sound and is expected to function as designed.

Spreadsheet

The attached spreadsheet shows the information for criteria 1 thru 10. Only DCX needs to supply additional information to complete all criteria. Referring to the spreadsheet, some key observations include:

- The CES design has the highest power rating.
- The CES design has the highest power rating per square foot of floor area.
- The Midas Green design has the lowest cost per kw.
- Midas Green has the highest production rate.
- Midas Green has the lowest cost per miner.
- The suppliers all show a significant hash-rate improvement over a non-immersion system. The numbers shown appear to be conservative and the actual improvement is likely higher.

Recommendation

With the information provided by the suppliers, the following ranking is recommended.

1. CES Intelliflex
2. Midas Green Technologies.
3. DCX
4. Rykor Energy Solutions.

Recommend to buy only one container in the beginning for testing in the field. The soonest we can get one container delivered to Compute North is 16 weeks.

Note: DCX is ranked third because their design for the Big Springs project is well understood and we have communicated extensively with their project team. All of the suppliers have sound designs and should be considered especially if a large deployment is required that would exceed the production capability of any one supplier.

Shortlist of Potential 'Modular Container' Immersion Cooling Systems

	Container Dimensions (ft)			Maximum Power per Container	Power per ft^2 Floor Area	Cost per Container	Cost per KW	Miners per Container	Cost per Miner	Delivery per Container	Container Production Rate	Hashrate Improvement vs non Immersion	Notes (see below the speadsheet)
Supplier	Length	Width	Height	KW	KW/ft^2	($)	$/KW		$/miner	Weeks	Number supplied over delivery period	Percent	
DCX	40			3200								40	
CES Intelliflex	60	13	12	5000	6.4	2,500,000	500	1152	2170	16	18	32	1, 2
RyKor Energy	40	8	9.6	923	2.9	1,298,000	1207	384	3380	16	10	20	3
Midas Green	53	8.5	9.5	1840	4.1	800,000	435	480	1667	20	40	>20	4

Note 1: Maximum power of largest container is actually 6000 KW. Reduced to 5000 KW for conservatism

Note 2: Under normal conditions production rate is about 20 to 21 containers per 16 week delivery period.

Note 3: Initial production rate of 10 containers/delivery period increases to 12 containers/4 weeks thereafter.

Note 4: A cooling container with dimensions of 40(ft) x 8(ft) x 9.5(ft) is also required